

## Claims

We claim:

1. A method for computing an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a same number of fields, said BA equal to  $(BR + BR1/J1)/J2$ , said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer, said method comprising:

determining BR1, J1, and J2 such that  $J2/(1+(BR1/BR)/J1)$  as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculating a quotient Q1 and remainder R1 from integer division of BR1 by J1;

calculating a quotient Q2 and remainder R2 from integer division of  $(BR+Q1)$  by J2;

initializing to zero accumulators A1 and A2; and

executing N iterations, wherein  $N > 1$ , and wherein executing each iteration includes:

adding R1 to A1;

if  $A1 \geq J1$ , then adding 1 to A2 and decrementing A1 by J1;

setting  $BA=Q2$  and adding R2 to A2;

if  $A2 \geq J2$ , then adding 1 to BA and decrementing A2 by J2.

2. The method of claim 1, wherein determining BR1, J1, and J2 includes computing BR1, J1, and J2.

1 3. The method of claim 1, wherein determining BR1, J1, and J2 includes receiving as input BR1,  
2 J1, and J2.

1 4. The method of claim 1, wherein J1 is a multiple of 10.

1 5. The method of claim 1, wherein  $J1 > J2$ .

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1 6. A computer code that computes an average bits/frame (BA) for frames extracted from a buffer  
2 used for video encoding and decoding, each said frame having a same number of fields, said BA  
3 equal to  $(BR + BR1/J1)/J2$ , said BR1, J1, and J2 each a positive integer, said BR a bit rate in  
4 bits/sec, said BR1/BR a positive integer, said computer code including an algorithm programmed  
5 to:

6 determine BR1, J1, and J2 such that  $J2/(1+(BR1/BR)/J1)$  as evaluated in floating point is  
7 approximately equal to FR, said FR a frame rate in frames/sec;

8 calculate a quotient Q1 and remainder R1 from integer division of BR1 by J1;

9 calculate a quotient Q2 and remainder R2 from integer division of  $(BR+Q1)$  by J2;

10 initialize to zero accumulators A1 and A2; and

11 execute N iterations, wherein  $N > 1$ , and wherein to execute each iteration includes:

12 to add R1 to A1;

13 if  $A1 \geq J1$ , then to add 1 to A2 and to decrement A1 by J1;

14 to set  $BA=Q2$  and to add R2 to A2; and

15 if  $A2 \geq J2$ , then to add 1 to BA and to decrement A2 by J2.

1 7. The computer code of claim 6, wherein to determine BR1, J1, and J2 includes to compute  
2 BR1, J1, and J2.

1 8. The computer code of claim 6, wherein to determine BR1, J1, and J2 includes to receive as  
2 input BR1, J1, and J2.

1 9. The computer code of claim 6, wherein J1 is a multiple of 10.

1 10. The computer code of claim 6, wherein  $J1 > J2$ .

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1 11. A method of computing an average bits/frame (BA) for frames extracted from a buffer used  
2 for video encoding and decoding, each said frame having a variable number of fields,  
3 comprising:

4 defining BA1 as an average bits/frame for a two-field frame, said BA1 equal to  $(BR +$   
5  $BR1/J1)/J2$ , said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said  
6  $BR1/BR$  a positive integer;

7 defining BA2 as an average bits/frame for a one-field frame, said BA2 equal to  $(BR +$   
8  $BR1/J1)/(2*J2)$ ;

9 determining BR1, J1, and J2 such that  $J2/(1+(BR1/BR)/J1)$  as evaluated in floating point  
10 is approximately equal to FR, said FR a frame rate in frames/sec;

11 calculating a quotient Q1 and remainder R1 from integer division  $BR1/J1$ ;

12 calculating a quotient Q2 and remainder R2 from integer division  $(BR+Q1)/J2$ ;

13 calculating a quotient Q3 and remainder R3 from integer division  $(BR+Q1)/(2*J2)$ ;

14 initializing to zero accumulators A1, A2, B1, and B2;

15 executing N iterations, wherein  $N > 1$ , said executing iteration n of N relating to  
16 extracting a frame n from the buffer, said executing of iteration n including:

17 calculating BA1, including:

18 adding R1 to A1;

19 if  $A1 \geq J1$  then adding 1 to A2 and decrementing A1 by J1;

20 setting  $BA1=Q2$  and adding R2 to A2;

21 if  $A2 \geq J2$ , then adding 1 to BA1 and decrementing A2 by J2;

22 determining a number of fields  $F_n$  comprised by the frame  $n$ ;

23 if  $F_n$  is even then setting  $BA2=0$  else calculating  $BA2$  including:

24 adding  $R1$  to  $B1$ ;

25 if  $B1 \geq J1$ , then adding 1 to  $B2$  and decrementing  $B1$  by  $J1$ ;

26 setting  $BA2=Q3$  and adding  $R3$  to  $B2$ ;

27 if  $B2 \geq (2*J2)$ , then adding 1 to  $BA2$  and decrementing  $B2$  by  $(2*J2)$ ;

28 computing  $BA=(F_n/2)*BA1 + BA2$ , said  $(F_n/2)$  computed by integer division.

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1 17. A computer code that computes an average bits/frame (BA) for frames extracted from a  
2 buffer used for video encoding and decoding, each said frame having a variable number of fields,  
3 said BA a function of BA1 and BA2, said BA1 defined as an average bits/frame for a two-field  
4 frame, said BA1 equal to  $(BR + BR1/J1)/J2$ , said BR1, J1, and J2 each a positive integer, said  
5 BR a bit rate in bits/sec, said BR1/BR a positive integer, said BA2 defined as an average  
6 bits/frame for a one-field frame, said BA2 equal to  $(BR + BR1/J1)/(2*J2)$ , said computer code  
7 including an algorithm, said algorithm programmed to:

8       determine BR1, J1, and J2 such that  $J2/(1+(BR1/BR)/J1)$  as evaluated in floating point is  
9 approximately equal to FR, said FR a frame rate in frames/sec;

10       calculate a quotient Q1 and remainder R1 from integer division  $BR1/J1$ ;

11       calculate a quotient Q2 and remainder R2 from integer division  $(BR+Q1)/J2$ ;

12       calculate a quotient Q3 and remainder R3 from integer division  $(BR+Q1)/(2*J2)$ ;

13       initialize to zero accumulators A1, A2, B1, and B2;

14       execute N iterations, wherein  $N > 1$ , said iteration n of N relating to extracting a frame n  
15 from the buffer, wherein to execute iteration n includes:

16           to calculate BA1, including:

17               to add R1 to A1;

18               if  $A1 \geq J1$  then to add 1 to A2 and to decrement A1 by J1;

19               to set  $BA1=Q2$  and to add R2 to A2;

20               if  $A2 \geq J2$ , then to add 1 to BA1 and to decrement A2 by J2;

21           to determine a number of fields  $F_n$  comprised by the frame n;

22                   if  $F_n$  is even then to set  $BA2=0$  else to calculate  $BA2$  including:  
 23                   to add  $R1$  to  $B1$ ;  
 24                   if  $B1 \geq J1$ , then to add 1 to  $B2$  and to decrement  $B1$  by  $J1$ ;  
 25                   to set  $BA2=Q3$  and to add  $R3$  to  $B2$ ;  
 26                   to compute  $BA=(F_n/2)*BA1 + BA2$ , said  $(F_n/2)$  computed by integer division.

1       18. The computer code of claim 17, wherein  $F_n$  is 2 or 3.

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1     23. A method for computing  $Z$ , said  $Z = \sum_n Z_n$ , said  $\sum_n$  denoting a summation over  $n$  from 1 to  
 2      $N$ , said  $N$  a positive integer of at least 1, said  $Z_n = X_n/Y$ , said  $X_n = (I_{1n}/J_1)M_{1n} + (I_{2n}/J_2)M_{2n} + \dots +$   
 3      $(I_{Kn}/J_K)M_{Kn}$ , said  $Y$  and said  $I_{kn}, J_k, M_{kn}$  ( $k=1, 2, \dots, K$ ) each a positive integer, said  $K$  a positive  
 4     integer of at least 1, said method comprising:  
 5         setting  $Z=0$ ,  $B=0$ , and  $A_k=0$  for  $k=1, 2, \dots, K$ ;  
 6         executing  $N$  iterations, said executing of iteration  $n$  of  $N$  including:  
 7             calculating a quotient  $Q_{kn}$  and a remainder  $R_{kn}$  from integer division  $I_{kn}/J_k$  for  $k=1,$   
 8              $2, \dots, K$ ;  
 9             calculating  $X_n = \sum_k [Q_{kn}M_{kn}]$  as summed over  $k$  from 1 to  $K$ ;  
 10            adding  $R_{kn}M_{kn}$  to  $A_k$  for  $k=1, 2, \dots, K$ ;  
 11            for  $k = 1, 2, \dots, K$ , if  $A_k \geq J_k$ , then adding 1 to  $B$  and decrementing  $A_k$  by  $J_k$ ;  
 12            if  $Y \neq 1$  then calculating a quotient  $Q_n$  and a remainder  $R_n$  from integer division  
 13             $X_n/Y$ , else setting  $Q_n = X_n$  and  $R_n = 0$ ;  
 14            setting  $Z_n = Q_n$  and adding  $R_n$  to  $B$ ;  
 15            if  $B \geq Y$ , then calculating  $Z_n = Z_n + 1$  and decrementing  $B$  by  $Y$ ;  
 16            adding  $Z_n$  to  $Z$ .

1     24. The method of claim 23, further comprising:  
 2         computing  $S = B + \sum_k (A_k/J_k)/Y$ , said  $\sum_k (A_k/J_k)$  denoting a summation over  $k$  from 1 to  
 3      $K$ , said  $S$  computed in floating point; and



1 27. A computer code that computes  $Z$ , said  $Z = \sum_n Z_n$ , said  $\sum_n$  denoting a summation over  $n$   
2 from 1 to  $N$ , said  $N$  a positive integer of at least 1, said  $Z_n = X_n/Y$ , said  $X_n = (I_{1n}/J_1)M_{1n} +$   
3  $(I_{2n}/J_2)M_{2n} + \dots + (I_{Kn}/J_K)M_{Kn}$ , said  $Y$  and said  $I_{kn}, J_k, M_{kn}$  ( $k=1, 2, \dots, K$ ) each a positive integer,  
4 said  $K$  a positive integer of at least 1, said computer code including an algorithm, said algorithm  
5 programmed to:

6 set  $Z=0$ ,  $B=0$ , and  $A_k=0$  for  $k=1, 2, \dots, K$ ;

7 execute  $N$  iterations, wherein to execute iteration  $n$  of  $N$  includes:

8 to calculate a quotient  $Q_{kn}$  and a remainder  $R_{kn}$  from integer division  $I_{kn}/J_k$  for  $k=1,$   
9  $2, \dots, K$ ;

10 to calculate  $X_n = \sum_k [Q_{kn}M_{kn}]$  as summed over  $k$  from 1 to  $K$ ;

11 to add  $R_{kn}M_{kn}$  to  $A_k$  for  $k=1, 2, \dots, K$ ;

12 for  $k = 1, 2, \dots, K$ , if  $A_k \geq J_k$ , then to add 1 to  $B$  and to decrement  $A_k$  by  $J_k$ ;

13 if  $Y \neq 1$  then to calculate a quotient  $Q_n$  and a remainder  $R_n$  from integer division  
14  $X_n/Y$ , else to set  $Q_n = X_n$  and  $R_n = 0$ ;

15 to set  $Z_n = Q_n$  and to add  $R_n$  to  $B$ ;

16 if  $B \geq Y$ , then to calculate  $Z_n = Z_n + 1$  and to decrement  $B$  by  $Y$ ;

17 to add  $Z_n$  to  $Z$ .

1 28. The computer code of claim 27, said algorithm further programmed to:

2 compute  $S = [B + \sum_k (A_k/J_k)]/Y$ , said  $\sum_k (A_k/J_k)$  denoting a summation over  $k$  from 1 to  
3  $K$ , said  $S$  computed in floating point; and

4           add S to Z.

1       29. The computer code of claim 27, wherein  $Y \neq 1$ .

1       30. The computer code of claim 27, wherein  $Y=1$ .

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1 31. A computer program product, comprising a computer usable medium having a computer  
2 readable program code embodied therein, wherein the computer code computes an average  
3 bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each  
4 said frame having a same number of fields, said BA equal to  $(BR + BR1/J1)/J2$ , said BR1, J1,  
5 and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer, said  
6 computer code including an algorithm programmed to:

7 determine BR1, J1, and J2 such that  $J2/(1+(BR1/BR)/J1)$  as evaluated in floating point is  
8 approximately equal to FR, said FR a frame rate in frames/sec;

9 calculate a quotient Q1 and remainder R1 from integer division of BR1 by J1;

10 calculate a quotient Q2 and remainder R2 from integer division of  $(BR+Q1)$  by J2;

11 initialize to zero accumulators A1 and A2; and

12 execute N iterations, wherein  $N > 1$ , and wherein to execute each iteration includes:

13 to add R1 to A1;

14 if  $A1 \geq J1$ , then to add 1 to A2 and to decrement A1 by J1;

15 to set  $BA=Q2$  and to add R2 to A2; and

16 if  $A2 \geq J2$ , then to add 1 to BA and to decrement A2 by J2.

32. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, wherein the computer code computes an average bits/frame (BA) for frames extracted from a buffer used for video encoding and decoding, each said frame having a variable number of fields, said BA a function of BA1 and BA2, said BA1 defined as an average bits/frame for a two-field frame, said BA1 equal to  $(BR + BR1/J1)/J2$ , said BR1, J1, and J2 each a positive integer, said BR a bit rate in bits/sec, said BR1/BR a positive integer, said BA2 defined as an average bits/frame for a one-field frame, said BA2 equal to  $(BR + BR1/J1)/(2*J2)$ , said computer code including an algorithm, said algorithm programmed to:

determine BR1, J1, and J2 such that  $J2/(1+(BR1/BR)/J1)$  as evaluated in floating point is approximately equal to FR, said FR a frame rate in frames/sec;

calculate a quotient Q1 and remainder R1 from integer division  $BR1/J1$ ;

calculate a quotient Q2 and remainder R2 from integer division  $(BR+Q1)/J2$ ;

calculate a quotient Q3 and remainder R3 from integer division  $(BR+Q1)/(2*J2)$ ;

initialize to zero accumulators A1, A2, B1, and B2;

execute N iterations, said N at least 1, said iteration n of N relating to extracting a frame n from the buffer, wherein to execute iteration n includes:

to calculate BA1, including:

to add R1 to A1;

if  $A1 \geq J1$  then to add 1 to A2 and to decrement A1 by J1;

to set  $BA1=Q2$  and to add R2 to A2;

if  $A2 \geq J2$ , then to add 1 to BA1 and to decrement A2 by J2;

22 to determine a number of fields  $F_n$  comprised by the frame  $n$ ;  
23 if  $F_n$  is even then to set  $BA2=0$  else to calculate  $BA2$  including:  
24 to add  $R1$  to  $B1$ ;  
25 if  $B1 \geq J1$ , then to add 1 to  $B2$  and to decrement  $B1$  by  $J1$ ;  
26 to set  $BA2=Q3$  and to add  $R3$  to  $B2$ ;  
27 to compute  $BA=(F_n/2)*BA1 + BA2$ , said  $(F_n/2)$  computed by integer division.

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33. A computer program product, comprising a computer usable medium having a computer  
 readable program code embodied therein, wherein the computer code computes  $Z$ , said  $Z = \sum_n$   
 $Z_n$ , said  $\sum_n$  denoting a summation over  $n$  from 1 to  $N$ , said  $N$  a positive integer of at least 1, said  
 $Z_n = X_n/Y$ , said  $X_n = (I_{1n}/J_1)M_{1n} + (I_{2n}/J_2)M_{2n} + \dots + (I_{Kn}/J_K)M_{Kn}$ , said  $Y$  and said  $I_{kn}, J_k, M_{kn}$  ( $k=1,$   
 $2, \dots, K$ ) each a positive integer, said  $K$  a positive integer of at least 1, said computer code  
 including an algorithm, said algorithm programmed to:  
 set  $Z=0$ ,  $B=0$ , and  $A_k=0$  for  $k=1, 2, \dots, K$ ;  
 execute  $N$  iterations, wherein to execute iteration  $n$  of  $N$  includes:  
 to calculate a quotient  $Q_{kn}$  and a remainder  $R_{kn}$  from integer division  $I_{kn}/J_k$  for  $k=1,$   
 $2, \dots, K$ ;  
 to calculate  $X_n = \sum_k [Q_{kn}M_{kn}]$  as summed over  $k$  from 1 to  $K$ ;  
 to add  $R_{kn}M_{kn}$  to  $A_k$  for  $k=1, 2, \dots, K$ ;  
 for  $k = 1, 2, \dots, K$ , if  $A_k \geq J_k$ , then to add 1 to  $B$  and to decrement  $A_k$  by  $J_k$ ;  
 if  $Y \neq 1$  then to calculate a quotient  $Q_n$  and a remainder  $R_n$  from integer division  
 $X_n/Y$ , else to set  $Q_n = X_n$  and  $R_n = 0$ ;  
 to set  $Z_n = Q_n$  and to add  $R_n$  to  $B$ ;  
 if  $B \geq Y$ , then to calculate  $Z_n = Z_n + 1$  and to decrement  $B$  by  $Y$ ;  
 to add  $Z_n$  to  $Z$ .